THE MIDDLE ULTRAVIOLET-VISIBLE SPECTRUM OF H_2 EXCITED BY ELECTRON IMPACT

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The electron-impact-induced emission spectrum of H_2 has been measured in the extended wavelength region 175-530 nm at a spectral resolution of 1.7 nm (FWHM). The laboratory spectra are characterized by underlying H_2 (a $^3\Sigma_g^+ \rightarrow$ b $^3\Sigma_u^+$) continuum emission, together with many strong lines assigned to the radiative decay of the *gerade* singlet states of H_2, and to members of the H Balmer series resulting from dissociative excitation of H_2.

We have measured calibrated emission spectra of H_2 from 175-530 nm produced by electron impact at 14, 19, and 100 eV to provide absolute emission cross sections and assist in the interpretation of Galileo Ultraviolet Spectrometer and Solid State Imager observations of Jupiter's aurora.

The laboratory spectra observed in the middle ultraviolet (MUV) and visible spectral regions are characterized by the underlying H_2 (a $\rightarrow$ b) continuum emission, together with many strong lines assigned to transitions from the *gerade* singlet states of H_2 (decaying to the B $^1\Sigma_u^+$ state), and to members of the H Balmer series resulting from dissociative excitation of H_2. The spectra have an extremely open rotational structure[1] with large spacing between the individual rotational lines in a given vibrational band.

The experimental apparatus[2] consists of an electron impact collision chamber in tandem with a medium resolution 1-meter UV-visible spectrometer. The MUV-visible spectrum of H_2 was measured by crossing a magnetically collimated beam of electrons with a beam of H_2 gas formed by a capillary array. Emitted photons, corresponding to radiative decay of collisionally excited states of H_2, were detected at 90° by the spectrometer equipped with suitable photomultiplier detectors.

No discrete features are observed at 14 eV electron impact energy and the measured emission spectrum at this energy can be attributed to the H_2 (a $^3\Sigma_g^+ \rightarrow$ b $^3\Sigma_u^+$) continuum. Excitation of the a $^3\Sigma_g^+$ state (which is forbidden under the selection rules for electric dipole transitions from the ground state) is a major dissociative channel of H_2 at low energy, with a peak cross section at 15.5 eV and a full width at half-maximum (FWHM) of the excitation function[3] of only 7 eV.

The high energy dependence of the H_2 (a $^3\Sigma_g^+ \rightarrow$ b $^3\Sigma_u^+$) continuum cross section has a rapid $1/E^3$ fall off with electron energy, E, above 50 eV. This fall off can already be seen to have occurred in the 100 eV spectrum (Figure 1) which is dominated by the strong H Balmer-β and Balmer-γ lines. Balmer series members up to n=8 can be identified in the 100eV spectrum. Transitions to the B $^1\Sigma_u^+$ state from levels of the GK $^1\Sigma_g^+$ state with v'=0,1,2,3, and from levels of the H $^1\Sigma_g^+$ state with v'=0,1,2 have been observed at both 100 eV and 19 eV electron impact energies. Weak H→B (2,0) P4, P6 and (2,1) P2, P4, P5 features observed by Watson and Anderson[1] at 370.2 and 388.9 nm, respectively, cannot be resolved in the present measurements. This is hardly surprising considering the pressure used in the present work is a factor of 100 lower.

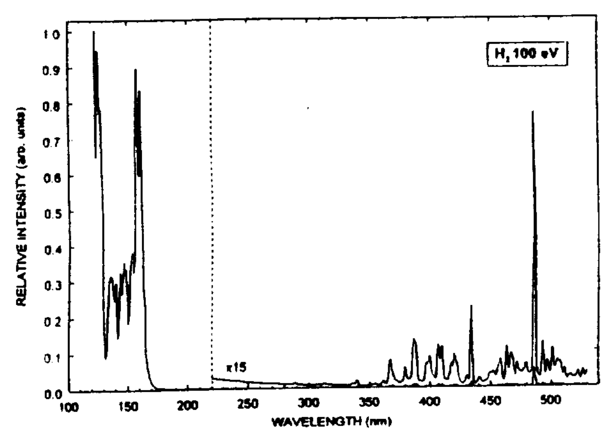

Fig 1. UV-visible emission spectrum of H_2 at 100eV

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References

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